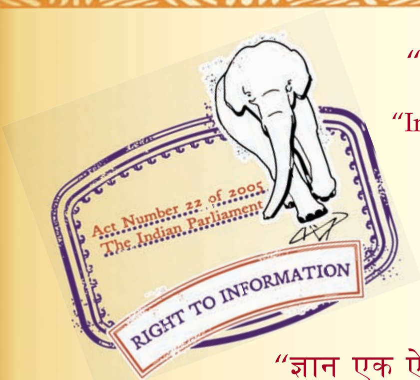
IS/ISO 11843-1 (1997): Capability of Detection, Part 1: Terms and Definitions [MSD 3: Statistical Methods for Quality and Reliability]



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भारतीय मानक

संसूचन सक्षमता

भाग 1 नियम व परिभाषाएँ

Indian Standard

CAPABILITY OF DETECTION

PART 1 TERMS AND DEFINITIONS

ICS 01.040.03; 03.120.30; 17.020

B U R E A U O F I N D I A N S T A N D A R D S
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

January 2010 **Price Group 3**

Statistical Methods for Quality and Reliability Sectional Committee, MSD 3

NATIONAL FOREWORD

This Indian Standard (Part 1) which is identical with ISO 11843-1 : 1997 'Capability of detection — Part 1: Terms and definitions' issued by the International Organization for Standarization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Statistical Methods for Quality and Reliability Sectional Committee and approval of the Management and Systems Division Council.

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to the following International Standard for which Indian Standard also exists. The corresponding Indian Standard which is to be substituted in its place is listed below along with its degree of equivalence for the edition indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 3534-1 : 1993[1)] Statistics — Vocabulary and symbols — Part 1: Probability and general statistical terms	IS 7920 (Part 1) : 2008 Statistics — Vocabulary and symbols: Part 1 Probability and general statistical terms (*third revision*)	Technically Equivalent

The technical committee responsible for the preparation of this standard has reviewed the provisions of the following referred standards and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
ISO 3534-3 : 1985	Statistics — Vocabulary and symbols — Part 3: Design of experiments
VIM : 1993	International vocabulary of basic and general terms in metrology

Annexes A and B of this standard are for information only.

[1)] Since revised in 2006.

Indian Standard

CAPABILITY OF DETECTION

PART 1 TERMS AND DEFINITIONS

Scope

This part of ISO 11843 specifies terms and definitions relating to the detection of a difference between an actual state of a system and its basic state.

The general concepts laid down in this part of ISO 11843, critical value of the response variable, critical value of the net state variable and minimum detectable value of the net state variable (see definitions Nos. 9 to 11), apply to various situations such as checking the existence of a certain substance in a material, the emission of energy from samples or plants, or the geometric change in static systems under distortion.

Critical values can be derived from an actual measurement series so as to assess the unknown states of systems included in the series, whereas the minimum detectable value of the net state variable as a characteristic of the measurement method serves for the selection of appropriate measurement processes. In order to characterize a measurement process, a laboratory or the measurement method, the minimum detectable value can be stated if appropriate data are available for each relevant level, i.e. a measurement series, a measurement process, a laboratory or a measurement method. The minimum detectable values may be different for a measurement series, a measurement process, a laboratory or the measurement method.

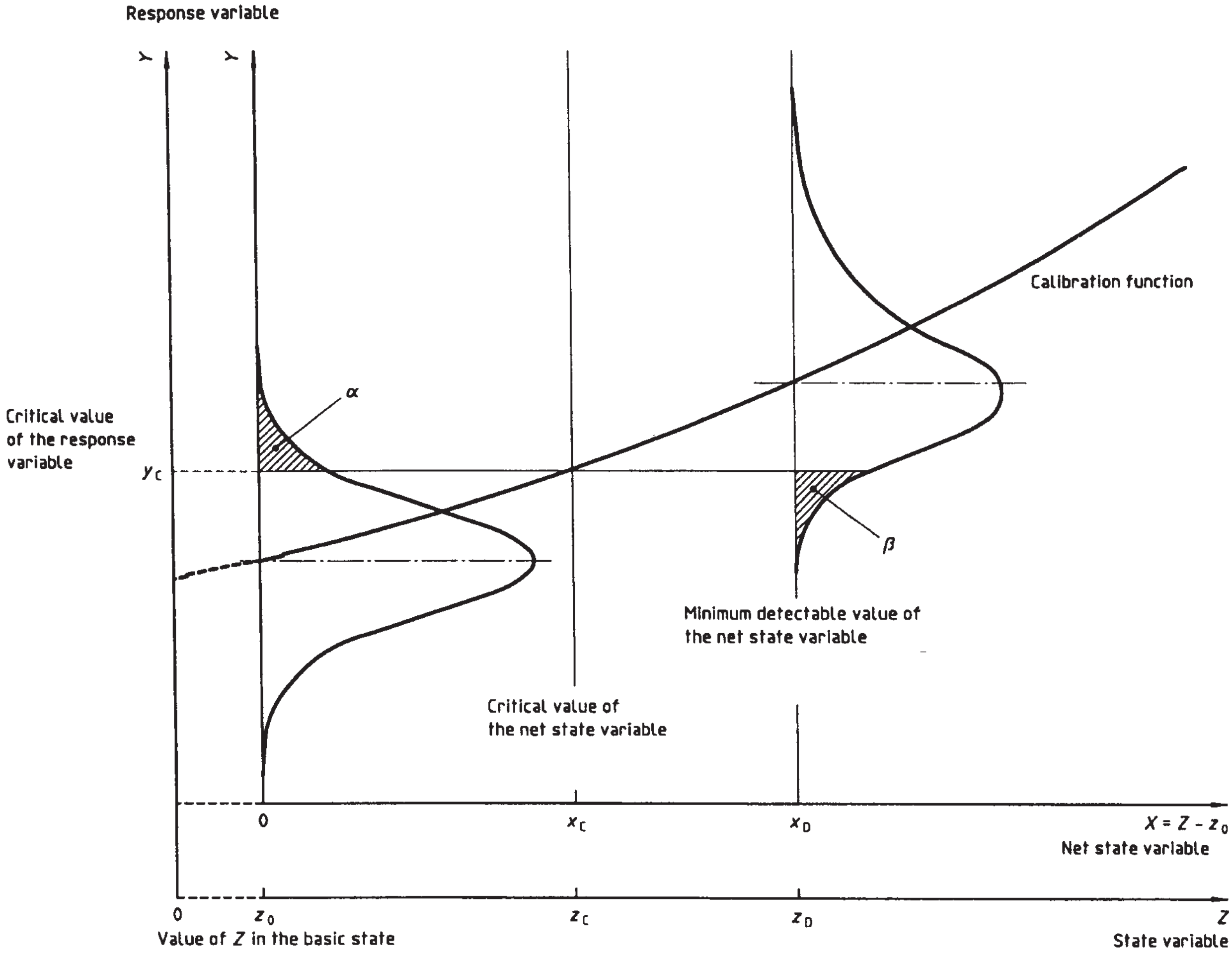
ISO 11843 applies to quantities measured on scales that are fundamentally continuous. It applies to measurement processes and types of measurement equipment where the functional relationship between the expected value of the response variable and the value of the state variable is described by a calibration function. If the response variable or the state variable is a vectorial quantity, the concepts of ISO 11843 apply separately to the components of the vectors or functions of the components.

NOTE — Definitions Nos. 6 and 11 refer to theoretical quantities which in reality remain unknown. Estimates of these theoretical quantities can be determined from experimental results.

Terms and definitions

Without restriction to the general applicability of this part of ISO 11843, it is assumed that the net state variable (see No. 4) is non-negative and that the calibration function (see No. 6) is strictly monotonically increasing. See also note 1 of definition No. 9.

Figure 1 illustrates some of the concepts defined. The form of the distribution of the response variable and the calibration function is only an example and does not imply any restriction to a particular type of distribution. The symbols used in this part of ISO 11843 refer to figure 1 and are illustrative. They do not form a normative part of this part of ISO 11843.



Z State variable
z_0 Value of the state variable in the basic state
X Net state variable, $X = Z - z_0$
x_C Critical value of the net state variable
x_D Minimum detectable value of the net state variable
Y Response variable
y_C Critical value of the response variable
α Probability of an error of the first kind
β Probability of an error of the second kind for $X = x_D$

Figure 1 — Calibration function, critical value of the response variable, critical value of the net state variable and minimum detectable value of the net state variable

1
state variable
Z
quantity describing the state of a system

NOTES

1 Generally, a system is characterized by more than one state variable. However, depending on the scope of the investigation, only one state variable is selected for the purpose of detecting a difference between an actual state and the basic state.

2 Usually the selected state variable attains its smallest value in the basic state.

EXAMPLES

a) Concentration or amount of a substance in a mixture of substances.

b) Intensity (energy density, power density, etc.) of the energy (radiation, sound, etc.) emitted by a source.

c) Geometric change in a static system when it is distorted.

2
basic state
specific state of a system for use as a base for the evaluation of actual states of the system

EXAMPLE

A state of equilibrium or of an extreme condition.

3
reference state
state of a system, the deviation of which from the basic state is assumed to be known with respect to the state variable, *Z*

4
net state variable
X
difference between the state variable, *Z*, and its value in the basic state, z_0

NOTES

1 The net state variable constitutes a derived variable following an interval scale, the zero of which corresponds to the value of the state variable in the basic state.

2 If the value of the state variable in the basic state is unknown (as is often the case), only the value of the net state variable can be measured but not that of the state variable itself.

3 If the assumption is made that the basic state is represented by the zero value of the state variable, the net state variable is conceptually equivalent to the state variable itself.

5
response variable
Y
variable that shows the observed results of an experimental treatment [ISO 3534-3:1985]

For the purposes of ISO 11843, this general definition is understood in the following specialized form:

directly observable surrogate for the state variable, *Z*

NOTE — The expected value of the response variable is related to the net state variable, *X*, via a calibration function.

EXAMPLE

If the state variable is the concentration or amount of a substance and a spectroscopic measurement method is used, the response variable might be a peak height or the area under a peak.

6
calibration function
functional relationship between the expected value of the response variable and the value of the net state variable, *X*

NOTES

1 See paragraph 1 in "Terms and definitions".

2 In graphical representations of a calibration function, the response variable is usually represented by the ordinate and the net state variable by the abscissa; see figure 1.

3 The calibration function is conceptual and cannot be determined empirically. It is estimated through calibration.

7
calibration
complete set of operations which estimates under specified conditions the calibration function from observations of the response variable, *Y*, obtained on reference states

NOTE — As regards its essential content this definition is consistent with the definition of "calibration" in the *International Vocabulary of Basic and General Terms in Metrology*. However, it uses the terms defined in this part of ISO 11843.

8
measurement series
totality of all measurements, the evaluation of which is based on the same calibration

NOTE — Evaluation in this context means the conversion of response variable results into estimates of the net state variable by means of the estimated calibration function.

9

critical value of the response variable

y_C

value of the response variable, Y, the exceeding of which leads, for a given error probability α, to the decision that the observed system is not in its basic state

NOTES

1 If the net state variable is negative or the calibration function is strictly monotonically decreasing, this definition has to be adjusted accordingly.

2 The critical value of the response variable is the critical value of a statistical test of the null hypothesis "The state under consideration is not different from the basic state with respect to the state variable" against the alternative hypothesis "The state under consideration is different from the basic state with respect to the state variable".

The test statistic of the above-mentioned statistical test, i.e. the response variable result, is the observed value in the case of a single measurement or a central value (e.g. average, median) in the case of repeated measurements.

3 If the null hypothesis is true and the above rule of drawing conclusions is obeyed, the probability of wrongly rejecting the null hypothesis (error of the first kind) is α.

4 The critical value of the response variable depends on:

— the specified probability α (probability of the error of the first kind; see also "significance level" in ISO 3534-1);

— the reference states chosen for calibration;

— the sample size chosen for calibration;

— the sample size chosen for the investigation of an unknown state;

— the kind of central value (e.g. average, median, etc.) derived from the observed values in the case of repeated measurements;

— the variation in the measurement system.

5 The range of critical values of the response variable resulting from different calibrations depends on random influences and variations of properties of the measurement system over time. Due to these disturbing influences, each critical value of the response variable is valid only for the corresponding measurement series.

10

critical value of the net state variable

x_C

value of the net state variable, X, the exceeding of which leads, for a given error probability α, to the decision that the observed system is not in its basic state

NOTES

1 The critical value of the net state variable is the value of the net state variable allocated to the critical value of the response variable by use of the estimated calibration function.

2 See note 1 of No. 9.

3 The critical value of the net state variable is the value, based on an error probability α, the exceeding of which by the estimated value of the net state variable leads to the rejection of the null hypothesis "The state under consideration is not different from the basic state with respect to the state variable".

4 Notes 3 to 5 of No. 9 are valid as regards content.

11

minimum detectable value of the net state variable

x_D

true value of the net state variable, X, in the actual state that will lead, with probability $(1-\beta)$, to the conclusion that the system is not in the basic state

NOTES

1 See note 1 of No. 9.

2 The minimum detectable value specifies the true value of the net state variable for which the probability of wrongly not rejecting the null hypothesis (error of the second kind) is β.

3 Notes 4 and 5 of No. 9 are valid as regards content.

4 The minimum detectable value predicted from data of an actual measurement series characterizes the capability of detection of the measurement process for this specific measurement series.

5 The minimum detectable values for different measurement series

— of a particular measurement process,

— of different measurement processes of the same type,

— of different types of measurement processes based on the same measurement method,

can be understood as realizations of random variables where the parameters of the probability distribution of these variables can be considered as characteristics of the measurement process, the type of measurement process or the measurement method, respectively.

6 The minimum detectable value of the measurement method may be used for the selection of measurement processes and methods for further measurements. A measurement process or a measurement method is suitable for a certain measurement task if the minimum detectable value is equal to or smaller than a specified value (i.e. a specified requirement on scientific, legal or other reasons regarding the capability of detection).

Annex A
(informative)
Terms used in chemical analysis

An important field of application of the terms and definitions in this part of ISO 11843 as well as the methods given in ISO 11843-2 (under preparation) is chemical analysis. If the correspondences between the general terms used in this part of ISO 11843 and the terms used in chemical analysis listed in table A.1 are used, specific definitions of the terms "critical value" and "minimum detectable value" are obtained which are given below.

Table A.1

General term	Term used in chemical analysis
observed system	material to be analysed
state (of a system)	chemical composition (of the material to be analysed)
state variable	concentration or amount of the analyte
basic state	chemical composition of the blank material
reference state	chemical composition of a reference material
net state variable	net concentration or amount of the analyte, i.e. the difference be- be analysed and that in the blank material rence entre la concentration ou la quantité de l'analyte dans le ma-
response variable	
calibration function	
calibration	identical to general term
measurement series	
critical value of the response variable	[1]
critical value of the net state variable	critical value of the net concentration or amount [2]
minimum detectable value of the net state variable	minimum detectable net concentration or amount [3]

1) Corresponding definition is:
critical value of the response variable
value of the response variable the exceeding of which leads, for a given error probability α, to the decision that the concentration or amount of the analyte in the analysed material is larger than that in the blank material

2) Corresponding definition is:
critical value of the net concentration or amount
value of the net concentration or amount the exceeding of which leads, for a given error probability α, to the decision that the concentration or amount of the analyte in the analysed material is larger than that in the blank material

3) Corresponding definition is:
minimum detectable net concentration or amount
true net concentration or amount of the analyte in the material to be analysed which will lead, with probability $(1 - \beta)$, to the conclusion that the concentration or amount of the analyte in the analysed material is larger than that in the blank material

Annex B
(informative)

Bibliography

[1] ISO 3534-1:1993, *Statistics — Vocabulary and symbols — Part 1: Probability and general statistical terms.*

[2] ISO 3534-3:1985, *Statistics — Vocabulary and symbols — Part 3: Design of experiments.*

[3] VIM:1993, *International Vocabulary of Basic and General Terms in Metrology.*

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.org.in

Regional Offices:			*Telephones*
Central	:	Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	2323 7617 2323 3841
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